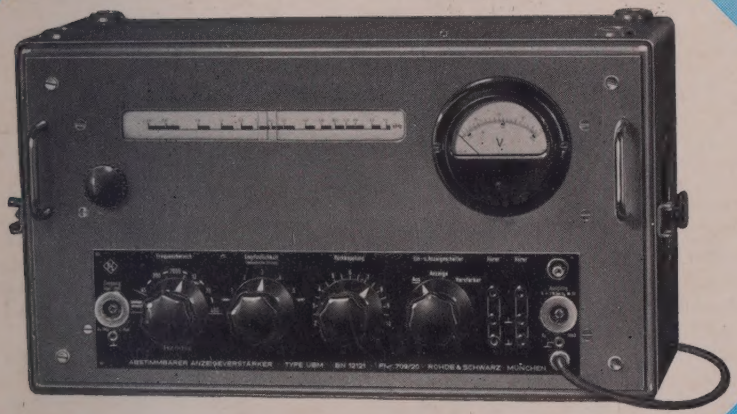
Type UBM TUNABLE INDICATING AMPLIFIER BN 12121



ROHDE & SCHWARZ · MÜNCHEN

DESCRIPTION

TUNABLE INDICATING AMPLIFIER

Type UBM BN 12121

DISTRIBUTED IN THE UNITED STATES BY
INSTRUMENT DIVISION
FEDERAL TELEPHONE AND RADIO COMPANY
A DIVISION OF I T & T
100 KINGSLAND ROAD, CLIFTON, N. J.

1 Specifications

Frequency range	45 cps to 400 kc
subdivided into 5 ranges	45 to 300/2000 cps/12/80/400 kc
Type of operation	resonant or non-resonant
Resonance width in tuned operation	about 1 to 10 %, variable
Sensitivity (at a bandwidth of about 2 %)	about 10 μv
Maximum input voltage	about 100 v
Voltage indication	on meter
calibration of the meter	linear up to 1/10 of full scale, above that (2 decades) logarithmic
Gain control in resonant operation	in 5 steps of 1 : 10 each and continuous by feedback
Gain control in non-resonant operation	in 5 steps of 1 : 10 each
Input	single-ended, 13-mm jack (coaxial)
Input impedance	1 MΩ in shunt with about 30 μμf
Output	single-ended, 13-mm jack; in parallel thereto 2 outputs for 3-contact headset plugs or for banana plugs
Output impedance	10 kΩ
Distortion of the output voltage	less than 1 % with meter disconnected and E_{out} lower than 5 v

Power supply	110/125/150/220 v, 40 to 60 cps (30 va)
Tubes etc.	3 tubes EF 12 1 tube EF 14 1 tube EZ 11 1 stabilizer 150 C 2 1 fuse 0.25 DIN 41571 1 miniature neon lamp 220 v
Dimensions	19 3/4" x 11" x 10 1/4" (R&S Size 46 Standard Cabinet)
Weight	approx. 33 lbs.

2 Purpose and Application

Thanks to its wide frequency and voltage range, the Tunable Indicating Amplifier UBM is a versatile instrument for the audio-frequency engineer in the laboratory and production test department as well as in the hands of the carrier-frequency engineer who needs it for monitoring. In the laboratory and the test shop the set may a. o. be a great help as a null detector of an a–f or r–f test bridge. For example, it can be used for capacitance, inductance and frequency test bridges or in conjunction with the Power Factor Test Bridge VKB of this company. Thanks to the good selectivity of the indicating amplifier it is then unimportant whether the generator feeding into the test bridge produces a sinusoidal or a distorted test signal. It is likewise of no importance whether there are harmonics produced in the test bridge as may be the case due to saturation of an input or output transformer or in the unknown itself. In all cases, that is in spite of the harmonics present at the input of the indicating amplifier, it will be possible to obtain a sharp and thus an unambiguous minimum of the null voltage so that the given measuring accuracy of a bridge is fully utilized.

The fundamental frequency can be emphasized 100 : 1 in relation to harmonics, by feedback through an RC phase shifter. Essential for the indication is then virtually only the fundamental frequency of the input voltage. Even more pronounced is the boosting of the fundamental frequency with reference to an unwanted frequency lower than the useful frequency as there is additionally a negative feedback provided for this frequency. At a frequency ratio (useful frequency/unwanted frequency) of 2 : 1, the unwanted frequency will then be attenuated about 250 : 1 while the amplitude ratio of 1000 : 1 can be attained in the case of a frequency ratio of 10 : 1. This is of particular importance where the test voltage (e. g. 1000 cps) contains a large amount of hum (e. g. 50 cps). A non-resonant null indicator would here be of no use for an exact bridge measurement. The Indicating Amplifier UBM retains the same selective properties when used as a voltage amplifier. Here, it may be used as an amplifying resonant filter whose bandwidth is continuously variable (by means of feedback) from

about 1 to 10%. The gain is then about 1000/bandwidth, that is, approximately, 100,000 at a bandwidth of 1%. The distortion of the output voltage of the UBM is less than 1%, the sole condition being that the indicator section of the UBM is disconnected and an output voltage of 5 v not exceeded.

The Indicating Amplifier UBM is particularly advantageous because it is appreciably selective even at lower frequencies when localizing a hum voltage source. This is of interest, for example, where it is necessary to find the respective point of origin, if several hum voltages are present at the same time in an assembly of mains-supplied sets. In especially complex cases, it is for instance possible to proceed so that the individual sets are fed from generators at differing (mains) frequencies while the individual noise sources are localized with the aid of the UBM. The indicating amplifier is capable of reading reliably separated such frequencies as, for example, 45 cps, 50 cps and 55 cps. The UBM finds further application in the field of the carrier-frequency technique where it can be tuned to the audio frequencies, translator frequencies and carrier frequencies encountered in a carrier-frequency system. Furthermore, the indicating amplifier makes possible to check, in such systems, a. o. the sharply rejecting separating filters of the various channels or to determine the near-end cross-talk attenuation. Also possible is a rough check on the distortion by carrying out a wave analysis with the aid of the UBM. Finally, the set may likewise be used as an RC generator (frequency range 45 cps to 400 kc) if no exacting demands are made with respect to distortion and frequency accuracy.

3 Function and Construction

Shown in Fig. 1 is a simplified circuit diagram of the Tunable Indicating Amplifier UBM. Fundamentally, the set operates as follows: The voltage to be indicated in selective or non-resonant operation passes through the input attenuator adjustable in 5 steps to the tube Rö 1 effective as an aperiodic preamplifier and as a buffer stage. From there, it passes on to the amplifier stage Rö 2 switched over at will to operate as a selective

or non-resonant circuit, and from the outpout of this tube to the non-resonant power stage Rö 4. The crystal diode Gl 1 and the moving-coil meter I 1 serve respectively to rectify and indicate the output voltage.

The selection of the desired frequency is made in the RC phase shifter placed between the plate and the grid of the tube Rö 2. Here, the cathode follower Rö 3 is solely an impedance transformer between the phase shifter output (which is of very high impedance particularly at low frequencies) and the feedback loop. A maximum output voltage (indication) is obtained in the phase shifter, if the phase shifter effects a phase shift of about

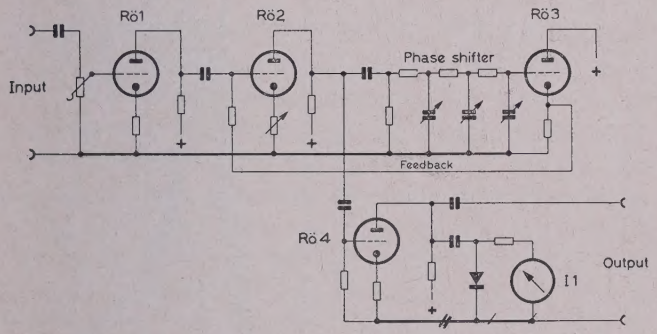


Fig. 1. Simplified ciucuit diagram of the Tunable Indicating Amplifier Type UBM

180° at the frequency of the input voltage. The feedback is variable up to self-oscillation of the amplifier, by means of the adjustable cathode resistor Rö 2. The gain is at its maximum and the bandwidth at the same time at its minimum immediately before the amplifier begins to oscillate. An amplification factor up to 100,000 can be achieved in case of an extreme adjustment of the feedback. The bandwidth is then approximately 1 % of the frequency adjusted for. A continuous adjustment of the bandwidth up to about 10 % has been made possible by the adjustability of the feedback. The overall amplification of the set decreases in the same measure as the bandwidth increases. Towards higher and lower frequencies, the feedback becomes less and less effective because of the increasing phase difference; thus the output voltage drops rapidly.

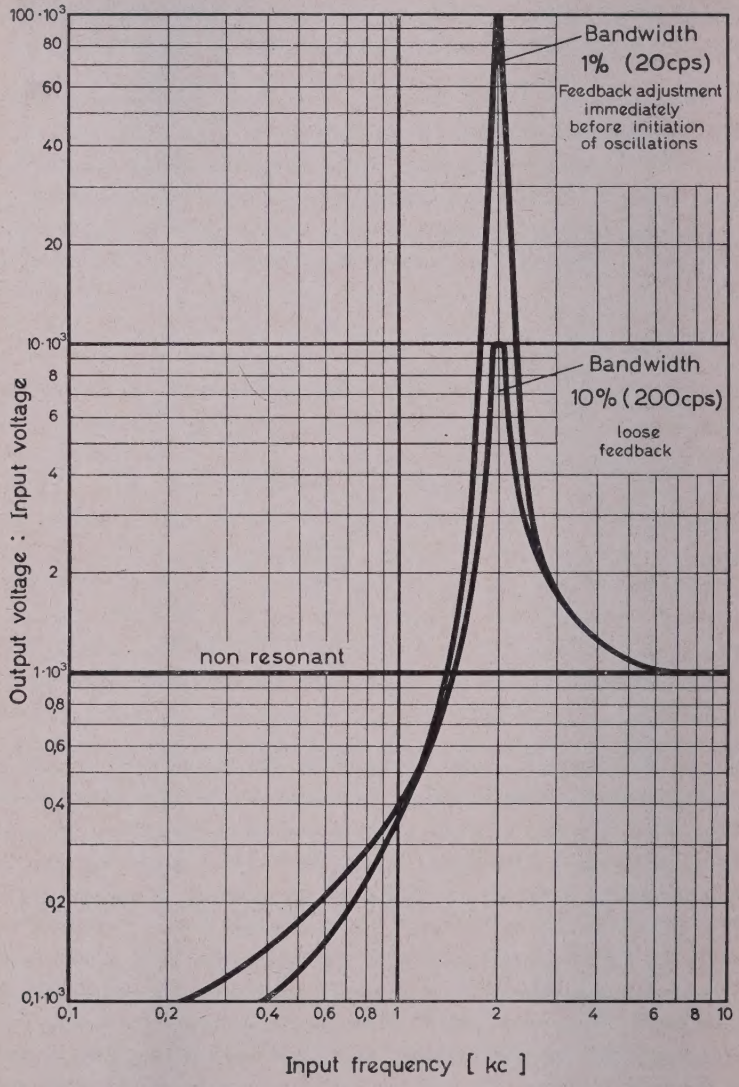


Fig. 2. Selectivity curve as a function of the degree of feedback

Shown in Fig. 2 is the basic slope of the selectivity curve, corresponding to the phase shifter adjustment for a useful frequency of 2 kc. As demonstrated by the curve, the 1 st harmonic (4 kc) is attenuated about 85 : 1. For harmonics of a higher order, the attenuation is approximately 100 : 1. Still more pronounced is the attenuation for frequencies lower than he useful frequency adjusted for on the phase shifter, since the phase shifter, apart from the phase displacement, also causes a negative feedback to increase with decreasing frequency.

In the first position of the frequency range switch S 2 I through IV the entire amplifier operates in its non-resonant condition (see circuit diagram Fig. 3). Here, the phase shifter input is disconnected and the control grid of the tube Rö 3 is short-circuited to ground. The overall amplification factor is then 1000 on the average. In view of the logarithmic range of indication (100 : 1), continuous adjustability of the gain has not been provided for. However, the gain, that is the voltage selectivity of the set can be reduced by the input attenuator in 5 steps of 10 : 1 which is consequently in the ratio 10,000 : 1. The crystal diode Gl 1 serves as the rectifier of the output voltage while the moving-coil meter I 1 (100 µamps) permits to take the reading. The indicator section can be disconnected by means of S 3 in order to minimize the distortion of the output voltage. S 3 is also the mains switch. The logarithmic calibration of the meter is attained by the rectifier Gl 2 which has the effect of a voltage-dependent shunt resistance.

The power supply has been laid out for the four conventional mains voltages 110, 125, 150 and 220 v. The full-wave rectifier tube Rö 5 has been inserted to produce the plate voltage. The plate and screen voltages of the tubes Rö 1, Rö 2, Rö 3 are stabilized by the tube Rö 6. Besides, these tubes are heated by direct current. Thereby, a high degree of feedback can be obtained at a constant value and the very high voltage sensitivity (about 10 µv) can be utilized readily even if the set is tuned to the mains frequency. The cabinet of the set is of steel. A carrying handle each is provided on the two faces while the removable steel lid serves to protect the front panel during transportation. The four little cups on the top of the cabinet are provided to prevent a set having the same bottom dimensions, and placed on the UBM, from sliding down.

4 Operating Instructions

4.1 Putting in Operation

The set is factory-adjusted for operation from 220 v mains. To adapt the set for operation from one of the other voltages (110, 125 or 150 v), it is necessary to slacken off the four screws at the ends of the front panel, to remove the set from its cabinet and to overbridge the pair of clips, marked on the fuse strip by the available mains voltage, by a fuse 0.4 DIN 41571 (400 ma). For 220 v, a 250-ma fuse has been inserted. With the chassis properly replaced and connected to the mains, the set can be switched on with the r. h. knob (from position OFF to INDICATION). The small neon lamp over the coaxial output jack will flash up if the mains voltage is present.

4.2 Input

The shell of the coaxial input jack (l. h. corner) is connected to ground; the same holds for the telephone jack. If it is intended to make a connection to the UBM through a shielded cable, this cable must be equipped with a 13-mm plug (Order No. FS 413/1). The high input impedance of 1 MΩ in shunt with 30 μμf generally means only immaterial loading of the unknown.

4.3 Sensitivity and Feedback

The second knob (as viewed from left to right) enables an adjustment of the voltage sensitivity to be made in 5 decade steps. Step 5 is the most sensitive. In tuned operation, the sensitivity depends also on the degree of feedback varied by the knob FEEDBACK and thus on the bandwidth. The sensitivity rises with the increasing degree of feedback. Conversely, the bandwidth decreases as the degree of feedback is increased. With the FEEDBACK control turned counterclockwise all the way, the bandwidth is about 15 to 20 % while it is about 1 % at a still well-usable feedback adjustment. If one wants to maximize the sensitivity, the feedback must be

increased until the amplifier begins to oscillate; subsequently, the feedback must be reduced so far until the oscillations just cease. The beginning or the ceasing of the oscillations will be indicated by the sudden rise or drop of the output voltage. The amplifier must be readjusted if the degree of feedback was changed.

4.4 Output

The shell of the coaxial output jack and the telephone jack below it are taken to ground. The coaxial output jack is of use, for instance, if the set is employed as a (selective or non-resonant) voltage amplifier or if two amplifiers are connected in series through a coaxial cable in order to arrive at a very high far-off selectivity. The two outputs marked PHONES are in parallel with the coaxial output jack. The output impedance is roughly 10 kΩ.

4.5 Indication

In view of the purpose of the set, the scale of the meter has a coarse calibration only. Up to the first calibration mark, the indication is nearly linear, above this mark it is logarithmic. With the ON & INDICATION switch, the indicator section can be disconnected from the output by switching from INDICATION to AMPLIFIER. This is always recommended if it is intended to use the set as a voltage amplifier or a resonant filter and to minimize the distortion of the output voltage. If the output voltage is kept below 5 v (corresponding to a needle deflection of about 10 scale divisions, with the indication switched on for checking), the harmonic content is less than 1 %.

4.6 Tuning

The control knob in the lower l. h. corner is the frequency-range switch and changeover switch for non-resonant operation at the same time. Fine adjustment to the desired frequency is possible with the aid of the left knob in the middle. It should then be taken into account that the tuning is somewhat dependent on the feedback factor adjusted for, and thus on the

bandwidth. For this reason, the frequency scale has not been provided, as otherwise customary, with a continuous, narrow-spaced graduation but, rather, calibration points have been provided at certain intervals only (for instance, at 45, 50, 60, 70 cps and so forth). These calibration points are identified by marks whose lengths correspond to the frequency change as conditioned by the feedback. The position of a numbered calibration line corresponds to the tuning condition with the feedback increased until the oscillations are nearly about to start, i. e. to a feedback adjustment for a bandwidth of approximately 1 %. Conversely, at a bandwidth of 10 %, the tuning is always at the r. h. end of a mark. Consequently, it is necessary to make a readjustment if the feedback setting was changed. The other controls do not influence the tuning.

5 Replacement of Tubes

All 6 tubes of the UBM can be replaced without impairing the function of the set.

6 List of Electric Parts

(Reference numbers according of Circuit Diagram)

Ref. No.	Designation	Ratings	R&S Stock No.
C 1	Capacitor, paper, round	25,000 µµf/500 v	CRF 25 000/500
C 2	Capacitor, ceramic	3 µµf	CTS 3
C 3	Capacitor, tubular	16 µµf	CC 16
C 4	Capacitor, tubular	300 µµf	CC 300
C 5	Capacitor, paper, round	10,000 µµf/250 v	CRF 10 000/250
C 6	Capacitor, MP, round	4 µf/160 v	CMR 4/160
C 7	Capacitor, paper, round	100,000 µµf/250 v	CRF 100 000/250
C 8	Capacitor, MP, round	4 µf/160 v	CMR 4/160
C 9	Capacitor, electrolytic	700 µf/30 v	CM 700/30
C 10	Capacitor, MP, round	4 µf/160 v	CMR 4/160
C 11	Capacitor, paper, round	50,000 µµf/250 v	CRF 50 000/250
C 12	Capacitor, MP, round	8 µf/350 v	CMR 8/350
C 15	Capacitor, variable	3 x 500 µµf	CD 45311
C 16	Capacitor, tubular	40 µµf	CC 40
C 17	Capacitor, tubular	40 µµf	CC 40
C 18	Capacitor, tubular	30 µµf	CC 30
C 19	Capacitor, MP, round	4 µf/160 v	CMR 4/160
C 22	Capacitor, ceramic	5 µµf	CTS 5
C 23	Capacitor, ceramic	3 µµf	CTS 3
C 24	Capacitor, ceramic	2 µµf	CTS 2
C 25	Capacitor, ceramic	3 µµf	CTS 3
C 26	Capacitor, ceramic	3 µµf	CTS 3
C 27	Capacitor, ceramic	3 µµf	CTS 3
C 28	Capacitor ceramic	1 µµf	CTS 1
C 31	Capacitor, paper, round	25,000 µµf/250 v	CRF 25 000/250
C 32	Capacitor, MP, round	0.5 µf/250 v	CMR 0,5/250
C 33	Capacitor, MP, round	0.5 µf/250 v	CMR 0,5/250

Ref. No.	Designation	Ratings	R&S Stock No.
C 34	Capacitor, MP, round	1 µf/250 v	CMR 1/250
C 35	Capacitor, paper, round	1000 µµf/500 v	CRF 1000/500
C 36	Capacitor, MP, round	16 µf/350 v	CMR 16/530
C 37 C 38	Capacitor, MP, round	16 + 16 µf/350 v	CMR 16 + 16/350
C 39	Capacitor, electrolytic	700 µf/30 v	CM 700/30
C 40	Capacitor, electrolytic	700 µf/30 v	CM 700/30
Gl 1	Diode, crystal		GK 2071
Gl 2	Rectifier (meter)		GL 018
Gl 3	Rectifier, power		GL 345
I 1	Meter, moving-coil	100 µA	IP 23/100 µA
K 1	Cabel, connecting		LK 303
L 1	Choke		12121–21
L 2	Choke		DB 20/2
L 3	Choke		DB 40
L 4	Choke (filament)		12121–22
R 1	Resistor, depos. carbon	1.25 MΩ/0.25 w	WF 1,25 M/0,25
R 2	Resistor, depos. carbon	125 kΩ/0.25 w	WF 125 k/0,25
R 3	Resistor, depos. carbon	12.5 kΩ/0.25 w	WF 12,5 k/0,25
R 4	Resistor, depos. carbon	1.25 kΩ/0.25 w	WF 1,25 k/0,25
R 5	Resistor, depos. carbon	125 Ω/0.25 w	WF 125/0,25
R 6	Resistor, depos. carbon	6 MΩ/0.5 w	WF 6 M/0,5
R 7	Resistor, depos. carbon	600 Ω/0.25 w	WF 600/0,25
R 8	Resistor, depos. carbon	200 kΩ/0.5 w	WF 200 k/0,5
R 9	Resistor, depos. carbon	60 kΩ/0.25 w	WF 60 k/0,25
R 10	Resistor, depos. carbon	10 kΩ/0.5 w	WF 10 k/0,5
R 11	Resistor, deops. carbon, variable	250 Ω lin.	WS 5126/250

Ref. No.	Designation	Ratings	R&S Stock No.
R 12	Resistor, depos. carbon	1.6 kΩ/1 w	WF 1,6 k/1
R 13	Resistor, depos. carbon	3 kΩ/0.5 w	WF 3 k/0,5
R 14	Resistor, depos. carbon	125 kΩ/0.5 w	WF 125 k/0,5
R 15	Resistor, depos. carbon	6 kΩ/0.5 w	WF 6 k/0,5
R 16	Resistor, depos. carbon	5 kΩ/0.5 w	WF 5 k/0,5
R 17	Resistor, depos. carbon	2 kΩ/0.5 w	WF 2 k/0,5
R 21	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R 22	Resistor, depos. carbon	16 MΩ/0.5 w	WF 16 M/0,5
R 23	Resistor, depos. carbon	16 MΩ/0.5 w	WF 16 M/0,5
R 24	Resistor, depos. carbon	16 MΩ/0.5 w	WF 16 M/0,5
R 25	Resistor, depos. carbon	20 kΩ/0.25 w	WF 20 k/0,25
R 26	Resistor, depos. carbon	30 kΩ/0.5 w	WF 30 k/0,5
R 27	Resistor, depos. carbon	10 kΩ/0.25 w	WF 10 k/0,25
R 28	Resistor, depos. carbon	10 kΩ/0.25 w	WF 10 k/0,25
R 29	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R 30	Resistor, depos. carbon	60 kΩ/0.25 w	WF 60 k/0,25
R 31	Resistor, depos. carbon	60 kΩ/0.25 w	WF 60 k/0,25
R 32	Resistor, depos. carbon	400 kΩ/0.5 w	WF 400 k/0,5
R 33	Resistor, depos. carbon	400 kΩ/0.5 w	WF 400 k/0,5
R 34	Resistor, depos. carbon	400 kΩ/0.5 w	WF 400 k/0,5
R 35	Resistor, depos. carbon	3 MΩ/0.5 w	WF 3 M/0,5
R 36	Resistor, depos. carbon	2.5 MΩ/0.5 w	WF 2,5 M/0,5
R 37	Resistor, depos. carbon	3 MΩ/0.5 w	WF 3 M/0,5
R 40	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R 41	Resistor, depos. carbon	100 Ω/0.25 w	WF 100/0,25
R 42	Resistor, depos. carbon	2.5 kΩ/0.25 w	WF 2,5 k/0,25
R 43	Resistor, wire-wound, variable	1 kΩ lin.	WR 1101/1 k
R 44	Resistor, wire-wound, variable	50 Ω/lin.	WR 1101/50
R 45	Resistor, depos. carbon	8 kΩ/1 w	WF 8 k/1
R 46	Resistor, depos. carbon	10 kΩ/1 w	WF 10 k/1

Ref. No	Designation	Ratings	R&S Stock No
R 47	Resistor, depos. carbon	40 kΩ/0.5 w	WF 40 k/0,5
R 48	Resitor, wire-wound	6 kΩ/4 w	WD 6 k/4
R 49	Resistor, wire-wound, variable	1 kΩ lin.	WR 1101/1 k
R 50	Resistor, depos. carbon	125 Ω/0.5 w	WF 125/0,5
Rl 1	Lamp, neon, miniature	220 v	RL 210
Rö 1	Pentode		EF 12
Rö 2	Pentode		EF 14
Rö 3	Pentode		EF 12
Rö 4	Pentode		EF 12
Rö 5	Rectifier, full-wave		EZ 11
Rö 6	Stabilizer		150 C 2
S 1	Switch, wafer		SRN 311/2/32
S 2	Switch, step		12121–3
S 3	Switch, wafer		SRN 314/32
S 4	Fuse, strip		FD 601
Si 1	Fuse		0,25 DIN 41571
Tr 1	Transformer, power		TN 332/2

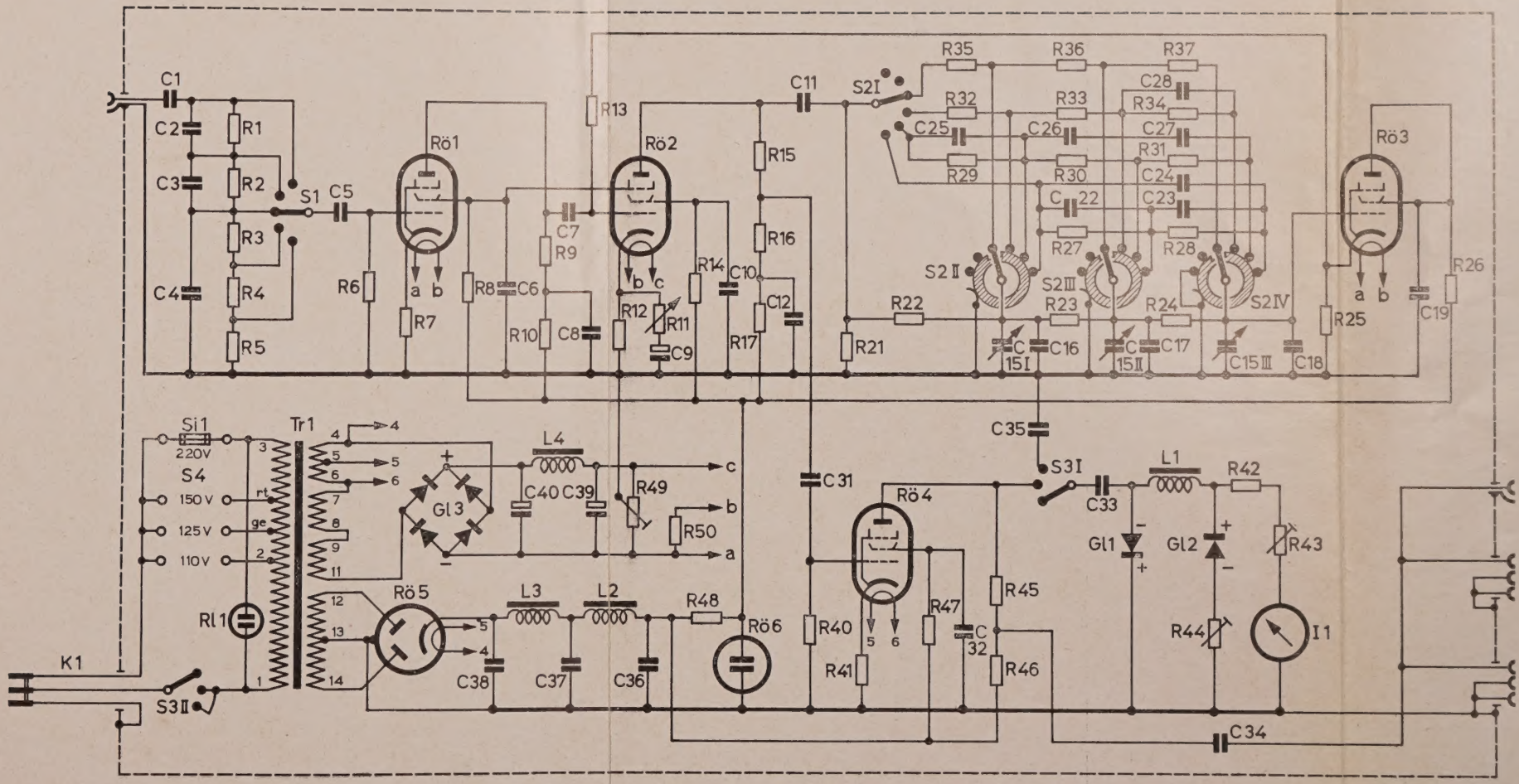


Fig. 3. Circuit diagram of the Tunable Indicating Amplifier Type UBM BN 12121

Guarantee. We guarantee our instruments **for 1 year** against faults arising from manufacturing or material defects (excepting tube failure). The lead and other seals of the instrument must be undamaged; goods must be consigned to our works carriage paid and at owner's risk and are returned carriage forward and at customer's risk.

Claims must be made in writing to reach us at the same time as the instrument, and should carry the number and date of our delivery note.

Type UBM TUNABLE INDICATING AMPLIFIER BN 12121

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